The spectral slope of the linear depolarization ratio measured with a triple-wavelength polarization lidar

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A polarization lidar measures the vertical profile of the linear depolarization ratio in the 180° backscatter direction. The particle linear depolarization ratio contains valuable information about the sphericity of aerosol particles. With the extension of the wavelength range from the UV and VIS towards the NIR, additional information about the particle size distribution can be retrieved. Non-spherical particles are challenging to describe in particle shape models. Especially the correct spectral slope of the linear depolarization ratio is difficult to describe in models. Therefore, quality-assured measurements of the depolarization ratio at several wavelengths are necessary to constrain the particle shape models.

The triple-wavelength polarization Raman lidar of the Leibniz Institute for Tropospheric Research provides such measurements. Additionally, is able to measure the extinction and backscatter coefficient at three wavelengths and thus the lidar ratio (extinction-to-backscatter ratio) at these wavelengths. We present the particle linear depolarization ratios at 355, 532, and 1064 nm for mineral dust and biomass burning smoke. Mineral dust is well known for its non-spherical shape with a PLDR (ratio of cross polarized to parallel polarized backscatter coefficient) of around 30% at 532 nm. The spectral slope shows an increase of PLDR from 355 to 532 nm and a decrease from 532 towards 1064 nm [1,2] for mineral dust. Biomass burning smoke usually has a low PLDR (<5%) at all three wavelengths. However, recent observations of smoke layers in the stratosphere exhibited large depolarization ratios with strong wavelength dependence. The PLDR decreases from 22% at 355 nm and 18% at 532 nm to only 4% at 1064 nm [3,4]. Additionally, the lidar ratios at all three wavelengths are measured, and they show an increase from UV towards the NIR. These measurements demonstrate the importance of the triple-wavelength polarization observations and provide input to the modelling community to test and improve their shape and refractive index assumptions for dust and smoke particles.

References

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